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A method for modeling the formation of CaII lines in the spectra of irradiated stellar atmospheres

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Abstract

We have developed a method for calculating deviations from LTE of level populations and profiles of selected spectral lines in stellar atmospheres in the presence of external radiation. The influence of Thomson scattering at the frequencies of the external radiation is considered. The method used to calculate model irradiated atmospheres in a semi-grey approximation has been improved. We have modified the NONLTE3 code used to determine the level populations to make it suitable for irradiated atmospheres. A model for the CaII atom including 42 energy levels of CaII, the ground state of CaIII, and 80 linearized transitions was constructed for these calculations. This atomic model takes into account the effect of all relevant collisional processes and radiative processes at the frequencies of the internal and external radiation. We investigated the correctness of the non-LTE calculations for the CaII ion by analyzing 16 lines of ionized calcium in the solar spectrum. The influence of uncertainties in the atomic data on the non-LTE level populations and CaII line profiles was also analyzed, and the van der Waals broadening coefficients C6 were refined. The scaling coefficient in the Dravin formula was taken to be 0.1. We found the non-LTE abundance corrections for most lines to be significant ($\Delta \log \varepsilon(Ca) = 0.05$-$0.15$dex), even under the conditions for the solar atmosphere. The lines of the $\lambda =$ 8498, 8542, 8662 Å infrared triplet can be adequately described. Differences in the mean calcium abundance obtained using different model atmospheres are smaller than 0.02 dex. Our final estimate of the mean calcium abundance in the solar atmosphere is $\log \varepsilon(Ca) = 6.31$, in good agreement with the meteoritic abundance, $\log \varepsilon(Ca) = 6.32$. © 2002 MAIK "Nauka/interperiodica".

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